The impact of dose prescription on treatment volume

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Purpose of Study

- Previously published literature has stressed the importance of:
  - prescribing
  - recording
  - reporting
  radiation therapy treatment doses and their treatment volumes clearly and unambiguously so that they can be easily tracked worldwide.

- One of the recommendations of ICRU 50 and its supplement ICRU 62 is to prescribe to a point inside the planning target volume (ICRU reference point) instead of prescribing to the periphery of the PTV (an isodose line).

- Our study evaluated the effects on the dose distribution of prescribing to the ICRU reference point versus prescribing to an isodose line.
ICRU 50 states:

“The most significant difference found in the literature appears to be the location where one prescribes and delivers the dose and how one reports the full treatment.”
Introduction: ICRU reference point

- The ICRU Reference Point is selected according to the following criteria:
  - Must be clinically relevant and representative of dose throughout the PTV
  - Should be easy to define in a clear and unambiguous way
  - The point should be chosen where the dose can be accurately determined
  - The point should not lie in a region where there is a steep dose gradient

- These recommendations are fulfilled if the ICRU reference point is:
  - Always at the center (central part) of the PTV
  - When possible, at the intersection of the beam axis
Methods

- Pinnacle treatment planning system
- Cases:
  - **Phantom:**
    - Drew 2 cm and 8 cm spherical diameter targets on 30 cm³ phantom
    - 4-field box
  - **Clinical:**
    - 4-field prostate
    - 10-field stereotactic body radiotherapy (SBRT) treatment plans
  - Different combinations of:
    - Block margin (0, 0.5 and 1.0 cm)
    - Prescriptions (ICRU or scaled)
  - 2 mm dose calculation grid
Phantom Plans
Methods

- Prescription Criteria:
  - Prescription 1 - ICRU: 100% dose to isocenter
  - Prescription 2 - Scaled: Pick an isodose line so that 95% volume gets 100% dose

- Our clinic tries to meet the following treatment planning goals (using ICRU):
  - 95% target volume gets 95% dose
Methods

Evaluations:

- The effect of different block margins (0, 0.5 and 1 cm) on doses and volumes
- The effect of different dose prescription (ICRU vs scaled) on normal tissue volumes

Plots:

- Calculated each plan and plotted dose vs. volume for comparison
Overview

- Plots:
  - DVH plots for phantom and clinical plans
  - Comparison of 2 different prescription methods
    - **Prescription 1** - ICRU: 100% dose to point
    - **Prescription 2** - Scaled: 95% volume gets 100% dose
      - Different scale factors were applied to these plans in order to meet the prescription criteria
  - Our clinic goals: 95% planning target volume gets 95% dose
Baseline case: 8 cm sphere

Solid line: ICRU prescription
Dotted line: Scaled prescription
Baseline case: 8 cm sphere

Solid line: ICRU prescription
Dotted line: Scaled prescription
Baseline Case: 2 cm sphere

Solid line: ICRU prescription
Dotted line: Scaled prescription
Example 1: Prostate

Prostate Case - PTV only

Solid line: ICRU prescription
Dotted line: Scaled prescription
Example 2: SBRT – small sized target

SBRT Target PTV only
Isodose Volume vs Dose
Case 1

Solid line: ICRU prescription
Dotted line: Scaled prescription
Example 3: SBRT – Large sized target

**SBRT Target PTV only**
**Isodose Volume vs Dose**
**Case 11**

- **Solid line:** ICRU prescription
- **Dotted line:** Scaled prescription

**Legend:**
- 0 cm block ICRU
- 0 cm block 82% Rx line
- 0.5 cm block ICRU
- 0.5 cm block 94% Rx line
- 1 cm block ICRU
- 1 cm block 98% Rx line
- 95% dose
Results – average 11 patients

Solid line: ICRU prescription
Dotted line: Scaled prescription

Average 11 cases

Volume (cm³)

Percent Isodose

0 cm block ICRU
0 cm block 88.5% Rx line
0.5 cm block ICRU
0.5 cm block 95.2% Rx line
1 cm block ICRU
1 cm block 97% Rx line
95% dose
Advantages of the ICRU definition of prescription:

- Can meet the dose prescription criteria using adequate block margins
- Can reduce the hot spot doses by as much as 30% as compared to the isodose prescription
- Uniformity in dose reporting can be achieved
Summary

- If the ICRU reference point is used as the dose prescription point, the dose to the healthy tissue will be lower as compared to prescribing to an isodose line.

- Prescribing to the ICRU reference point will make it more feasible to record the dose in a way that follows the ICRU recommendations on dose prescription, recording and reporting.
Thank you!

Questions?
Example 2: SBRT-small sized target

Solid line: ICRU prescription
Dotted line: Scaled prescription
Example 1: Prostate

Solid line: ICRU prescription
Dotted line: Scaled prescription
Example 3: SBRT – Large sized target

SBRT Target Case 11
Isodose Volume vs Dose

Solid line: ICRU prescription
Dotted line: Scaled prescription
Example 3: SBRT – Large sized target

Solid line: ICRU prescription
Dotted line: Scaled prescription
Baseline case: 8 cm sphere

Solid line: ICRU prescription
Dotted line: Scaled prescription
Baseline case: 2 cm sphere

Solid line: ICRU prescription
Dotted line: Scaled prescription
Baseline case: 2 cm sphere

Solid line: ICRU prescription
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